and column lines of a deflecting system matrix for the deflectors and reflect the formed block onto its proper position on the image plane.

According to another aspect of the present invention, there is provided a method and device for forming an image that comprises forming an image on an image plane by parallel forming of constituent blocks of an image through scanning the image plane with the help of a complementary scanning screen having a resolution that corresponds to the resolution of a block of an image screen. In the method and device the scanning beam for a scanning screen is divided into multiple components by a block deflecting system and each component of an image is placed into the same point in its corresponding block of an image plane for displaying the complete image. While activating different points of the scanning screen, each corresponding component scans its own block of the image plane.

L1
CONT.

## Page 7, Lines 1-6

L2

According to still a further aspect of the present invention, there is provided a method and apparatus for electronic image recording that comprises an image formed of constituent blocks wherein the scanning pattern is produced with the help of a complementary scanning screen and is deflected to the appropriate block of the final image using a block deflecting system.

## Page 7, Lines 13-17

L3

According to still another embodiment of the present invention, devices and

methods are provided for forming and electronically recording an image which comprise an image plane on which the image is present, a complementary scanning screen, and a block deflecting system.

Page 8, Lines 1-2

Figs. 2 and 2A are embodiments of a block deflecting system (BDS) element;

Page 8, Line 9

Fig. 6 is an embodiment of a complementary screen; and

Page 8, Lines 13-21

Referring to the drawings, Fig. 1 shows the basic structure of a device according to the present invention, which also can be used to implement the invention. Reference numeral 1 denotes the complementary scanning screen, 2 - an optic condensing system (optional), 3 - an optical transmission cable (optional), 4 - a polarizer (optional), 5 - the image plane on which the final image of higher resolution is to be formed, 6 - BDS (block deflecting system) matrix elements (described below), and 7 - scanning light beams.

Page 8, Line 22 - Page 10, Line 16

In Fig. 1, the complementary screen 1, illustratively is a display formed in a matrix of elements connected to row and column lines. Matrix element addressing is

performed by applying to the row and column lines appropriate signals for controlling the light emitting elements. The complementary screen 1 produces an optical picture that corresponds to a block of the image plane 5 on which the complete image is formed. The picture on screen 1 is formed either by any traditional addressing technique or speeded addressing using an orthogonal transformation OT addressing procedure, as described in the aforesaid prior application. Display 1 can be either a matrix of light emitting elements (e.g., an array of LED devices, injection lasers, etc.), or a matrix of elements that controls light transmission and light reflection. An outer signal (e.g., a video signal received by cable, RF transmission, etc.) is presented on complementary screen 1 (or computer transformed) in a manner to be broken up into the sequence of the blocks to be displayed on the image display 5.

An illustrative physical size of a block corresponds to the size of the complementary screen 1, e.g., 2.5x2.5 cm having 100x100 pixels - 4 pixels per mm/. In order to increase brightness and the pixel density, the image of the block on the complementary screen 1 can be optically compressed, e.g., 0.5x0.5 cm - 20 pixels per mm, to suit the size of a block to be finally displayed on the image plane 5.

The complementary screen 1 has a deflector system comprising a matrix of 100x100 elements, i.e., to correspond to 100x100 blocks. Each element is of the size of a block, so that the total screen size of 50x50 cm one obtains is $10^4$ pixels in a block compared to $10^3$ pixels to the total display.

An image formed on the blocks of complementary screen 1 is optically transmitted to a BDS matrix that adjoins the image plane 5. The BDS matrix has a number

of elements corresponding to the number of blocks that are to be formed on image plane (e.g., in the case of 100x100 blocks it has 100x100 elements). Each of the BDS matrix elements deflects the elements of the block for forming an image on the image plane so that the image formed by the image plane blocks cover the whole plane.

The image forming/recording procedures and devices of the invention utilize multiplication procedures based on outer matrix multiplication. Consider that A is a matrix representative of a complementary screen 1 matrix comprising $N \cdot N$ elements, $A = \{a_{i,j}\}$; $i,j = 1,N$. An element of matrix A corresponds to a pixel of the block formed on the complementary screen 1.

## Page 11, Line 7 - Page 13, Line 11

A light beam 7 is emitted from each light emitting element (pixel) of the complementary screen 1 and the light beam is amplitude modulated in proportion to the voltage applied to that element to control its information display content, e.g., color, hue, grey scale, etc. In order to increase the density and increase brightness of each complementary screen 1 element (pixel), an optic condensing system 2 may be used. Light beams formed on the complementary screen image 1, passing through condensing system 2 are compressed to form an image of smaller size than that appearing on complementary screen 1.

The blocks of the complete image formed on complementary screen 1 are to be transferred to and displayed on the image plane 5 in a block by block sequence. Where

the complementary screen 1 is located at a distance from the image plane 5, a light conductor 3, e.g., fiber optic cable, is used to transfer a formed block of an image from screen 1 to the image plane 5 where the complete image is to be formed. The complete image is displayed in blocks in their proper places on the image plane 5 through a matrix of BDS elements, described below. The light conductor 3 can include the necessary conventional optic elements - e.g., focusing cone, self focusing optic cable lens, etc., for further block image compression.

The proper place to display each block on image plane 5 is selected by applying voltage to the proper element (deflector) of the BDS matrix. Where necessary, special fluorescent covering of the image plane is used in order to transform coherent directed light into non-coherent dispersed light or to transform non-visible light produced by the complementary screen 1 into visible light, e.g., a liquid crystal image transformer may be used as an image plane. This uses the electro-optical effect in liquid crystals when falling light changes the conductivity of the photoconductive layer and potential relief of an adjacent liquid crystal layer that leads to an electro-optical effect in the liquid crystal layer that results in appearance of an image that can be directly viewed. The procedure is repeated for forming the entire image on image plane 5 block by block.

The BDS matrix is made in the form of a matrix of discrete type deflectors, e.g., acoustic optical deflectors, electro-optical deflectors, liquid crystal deflectors, etc., comprising line elements that deflect light produced by complementary screen 1 image into the appropriate line of the deflecting system matrix, and plane elements that deflect the light from

the line onto the image plane 5 to reproduce the block of the image on the image plane. The BDS deflectors are connected to appropriate row and column lines and driven by electric signals applied to these lines.

In Figs. 2 and 2A, a BDS element comprises mirror plates 8 placed in accordance with the line-by-line raster of the image block of the complementary screen 1. Mirror plates 8 are placed one above the other, with each plate corresponding to a scanning line of the image block of the complementary screen 1. Kerr-effect based double refracting crystal plates 9 are layered over the mirror plates 8 and transparent electrodes 10 are placed between the plates. Control voltages are applied to the transparent electrodes 10 via row and column lines.

## Page 13, Line 23 - Page 15, Line 2

The incident light beam received by the BDS element from the complementary screen 1 is divided into ordinary and extraordinary ray components. An extraordinary ray component 7 is deflected to the reflecting area of the mirror 8 from which it is reflected and falls onto the image plane 5. An ordinary ray component has another trajectory and can be eliminated using the polarizer 4. This is an optic polarizing filter that passes light with the proper fixed orientation of its polarization plane. That is, the ordinary rays do not produce any effect on the image plane 5. The ordinary rays are eliminated, e.g., by the use of a polarizer, and the resolution can be improved by the use of the condensing system 2 and by increasing the number of BDS matrix elements.

Another embodiment of a BDS element is shown in Figs. 3 (transverse view) and Fig. 4 (front view). Here, a BDS element that corresponds to each element of the complementary screen image block comprises an acoustic-optical deflector 12 in which an acoustic wave 13 is produced using a piezoelectric element 14. The acoustic wave is received by a sound wave acceptor 15. Each deflector is connected to light conductors 3. By applying an electric signal to a piezoelectric element 14 using a row and column matrix addressing system, the chosen deflector 12 is activated and the received light beam 7 is refracted by the sound wave and deflected into a light conductor 3', whose end has a focusing cone 11 (light conductor that widens along the light beam axis diameter). The focusing cone transforms the size of the transmitted part of the image in the conductor 3' so that it will correspond to the size of a block of an image to be displayed on the image plane 5.

Page 15, Line 17 - Page 17, Line 25

The resolution of the complementary screen 1 is multiplied by the number of deflectors comprising the BDS matrix. The image is formed consequently block by block, activating deflectors one by one and each block has a resolution of a screen block.

Instead of a matrix formed complementary screen 1, a non matrix collimated light beam may be used for the producing the screen. This is, for example, referring to Fig. 6, an active element 21 on the base of a semiconductor laser (similar to one used in laser projection devices) that is scanned by a cathode ray beam, produced by the beam source 19 and deflected by the deflecting system 20, producing an output having a resolution equal to

that of a block of an image plane. An example of a non-matrix complementary screen 1 is a "quantoscope" in which a cathode ray beam scans a semiconductor layer and induces laser radiation. This is a well known device.

In order to speed the image forming, more than one complementary scanning screen 1 may be simultaneously used and more than one BDS used to form blocks of an image on the image plane 59. That is, several blocks can be scanned from the complementary screen 1 and several blocks reproduced on the image plane 5 by several of the BDS devices at the same time.

A method for image recording is similar to that of image display as described above. To accomplish image recording, the light beams from different elements of a complementary scanning screen 1 scan a type of an image plane that can result in formation of output electric signals. This type of image plane is, for example, a photosensitive target where an electrostatic image is formed corresponding to the received light image. Commutation of the image elements is performed either by transforming the scanning light beam into an electron beam through an outer photoeffect or using a directly scanning light beam to commute image elements through an inner photoeffect.

For example, an image plane may comprise two separated photosensitive layers having a non-transparent conductive layer therebetween. Image forming light falls onto the outer photosensitive layer and changes its conductivity proportional to luminosity (light, color intensity). A scanning beam from the complementary screen changes the conductivity of the inner photosensitive layer. The non-transparent conductive layer placed therebetween

hinders mixing of scanning and outer image forming light and closes the circuit. The resulting output electric signal is proportional to the current value, and consequently to luminosity, produced by the light received by the outer image forming layer of the image plane. The resultant signal is outputted block by block. Block scanning may be performed either point by point or by using different scanning masks corresponding to different OT basic functions - scanning with the transformation.

L10
cont.

The above describes the process of transforming a light image into an electric signal. The output electric signal can be then recorded in a suitable recording medium - magnetic tape, etc. The resolution can be increased due to the manner of scanning - by optic compression scanning of the raster with the help of a condensing system 2. It is easier and more effective to decrease the diameter of the light dot by optic methods than to decrease the diameter of the electron beam and increase the number of image plane scanning points, which is equal to the multiplication of the complementary screen 1 pixels to the number of BDS matrix elements.

Page 18, Line 5 - Page 19, Line 16

L11

Here, in an embodiment of a BDS matrix element, the elements (pixels) of the complementary scanning screen 1 are activated one by one. The light beam emitted by each complementary screen element (pixel) is separated by plane BDS elements into the number of components and each component is deflected into a corresponding block and corresponding element of the block of the image plane. The BDS matrix is preferably located

behind the image plane.

All of the elements of the complementary screen 1 are activated one by one. By scanning the whole image plane 5, output signals are independently outputted from all of the scanned blocks of the image plane.

Here, as shown in Fig. 5a, BDS elements 18 are made in the form of partly transparent mirrors with coordinated coefficients of light transmission and light reflection. For example, there are three mirrors 13a, 13b, 13c in a line of a block deflecting system matrix that receives the light rays from the complementary screen 1. The first mirror 13a reflects 1/3 and transmits 2/3 of the light beam, the second mirror 13b reflects 1/2 and transmits 1/2 of the light passing through the first mirror, and the third mirror 13c reflects all of the light it receives and transmits none, so that each mirror reflects a light beam of equal intensity. The light rays 17 reflected from the mirrors are directed to fall onto the display screen 5.

Fig. 5(b) illustrates an arrangement where all the constituent blocks of the image plane are all scanned together in parallel. Complementary screen 1 this time forms a raster image (e.g., TV raster), so that each mirror deflects a corresponding part of the light emitted from screen 1 into the corresponding block of image plane 5 (each mirror corresponds to a block of an image plane). In the case of image recording mirrors can be placed directly behind the image plane associated, if necessary, with light focusing plate 30. In the case of image forming, there should be additionally used a space-time modulator - a matrix comprising an array of light modulators - placed between the image plane and the BDS matrix in order to independently modulate (gray scale, hue, etc.) the raster forming light in each block.

Each of the image blocks is finally formed by all of successively activated complementary screen elements and blocks do not interlace on the image plane.

Generated RE of complementary screen can be of either one or more colors. In the latter case, more than one modulator for one block can be used, e.g., one modulator for one of RGB (red, green, blue) colors. Also, more than one complementary screen can be used, e.g., one screen for ne of RGB color components.

Though passive element block deflecting systems can provide higher resolution because of more simple construction of block deflecting system matrix elements, and consequently possible higher degree of compression of the complementary scanning screen image, scanning with a transformation cannot be implemented.

Fig. 7 shows a holographic variant of an image forming device. The elements are:

1 - complementary scanning screen, 2- optic condensing system, 7- hologram forming light, 18- light dividers, 22- light multiplying matrix, 23- focusing elements, 24, 25- mirrors, 26- laser, 27- image restoring light, 28- laser beam widener, 29- light modulating screen, 30- a holographic optic element matrix (focusing plate), 31- hologram forming plane, and 32- holographic image forming light.

On complementary scanning screen 1 is presented a high resolution display

(e.g., 5x5 cm, 2500 lpi). This display is produced by a cathode ray tube, laser projection system, etc. That is, a high resolution raster picture of a block of an image to be formed is created. The block of the complementary screen 1 is optically condensed to obtain a resolution needed for holography (e.g., a block of 0.5x0.5 cm, 25,000 lpi). To explain further, a hologram-3D picture is formed as a result of diffraction of coherent light on a periodic structure (e.g., formed on a film). In order for the diffraction to take place, a typical light wavelength, $0.4-0.7 \times 10^{-6}$m the period of the periodic structure should be comparable to that of the light wave. The resolution 25,000 lpi - $10^{-6}$m is the minimal resolution needed for holography. The compressed block image is transmitted by reflection from mirror 24 to the deflecting matrix 22, in which it is multiplied by light dividing matrix elements 18 into many blocks covering the whole plane of the matrix 22. Screen 1 forms a raster picture (e.g., TV line raster), each raster forming dot is divided by elements 18 of IMM 22 into a number of components, corresponding to the number of blocks to be formed on plane 31, so that each component simultaneously forms a raster in its corresponding block. All of the blocks together cover the whole image plane.

Page 22, Line 16 - Page 23, Line 5

The holographic optic element matrix 30 focuses each block image onto the hologram forming plane 31. This plane 31 has, for example, a layer of photochrome material sensitive to complementary screen emitted light. Thus, on hologram forming plane 31 is formed a large scale hologram presenting an array of (e.g., 50x50) small blocks covering the

whole plane surface (this time 25x25 cm). The matrix of holographic optic elements 31 focuses light in a narrow spectral interval corresponding to specter emitted by complementary scanning screen 1. That is, it should not focus image restoring light 27 (this is a limitation present in a compact construction of the screen where the same deflecting matrix 22 is used to form both hologram and restoring light). In other variants e.g., matrix 22 is used only to form a hologram and restoring light 27 flooding plane 31 is formed by any of the different ways may as well be used lens matrix.

IN THE CLAIMS:

Please amend the claims pursuant to 37 C.F.R. 1.121 as follows (see the accompanying "marked up" version pursuant to 1.121):

48. (Amended) An image display system comprising:

(a) at least one complementary screen of one of light emitting or light source modulating devices in a two dimensional array of N (a real number) pixels, from which raster elements comprising one or more pixels are generated;

(b) a raster multiplying system comprising a plurality of optically connected light dividing elements, each said element to divide a raster element of the complementary screen into parts to simultaneously form copies of the generated raster elements, with said copies of said raster elements to be used in forming corresponding raster elements in P blocks, each block generally comprising a two dimensional array of pixels;